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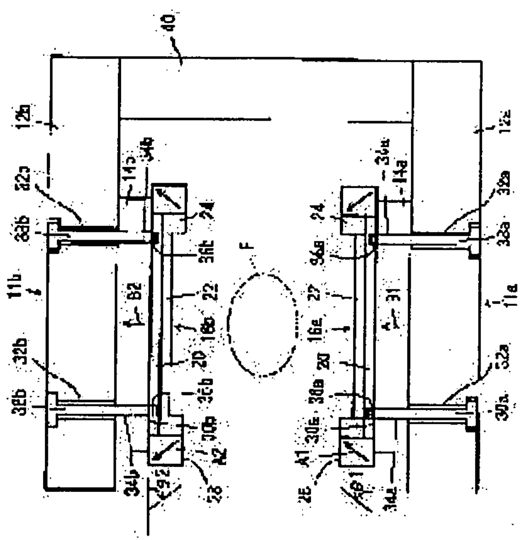
(54) MAGNETIC FIELD GENERATING APPARATUS AND ITS MANUFACTURING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a magnetic field generating apparatus and its manufacturing method that can suppress the lowering of magnetic field intensity and deterioration of magnetic field uniformity after transportation.
SOLUTION: This magnetic field generating apparatus 10 comprises a pair of plate yokes 12a, 12b. Permanent magnet groups 14a, 14b are arranged on the respective opposed face sides of a pair of plate yokes 12a, 12b, and magnetic pole plates 16a, 16b are stuck to the respective opposed face sides of the permanent magnet groups 14a, 14b. The permanent magnet groups 14a, 14b include permanent magnets 18. The magnetic pole plates 16a, 16b include annular projections 24 and permanent magnets 28 for preventing leakage magnetic flux, provided on the outer side faces of the annular projections 24. The permanent magnets 18, 28 include R-Fe-B-based magnets with the magnetization rate of 80% to 99.9%. In manufacture, the whole built-up magnetic field generating apparatus 10 is heated at 40° C-70° C.



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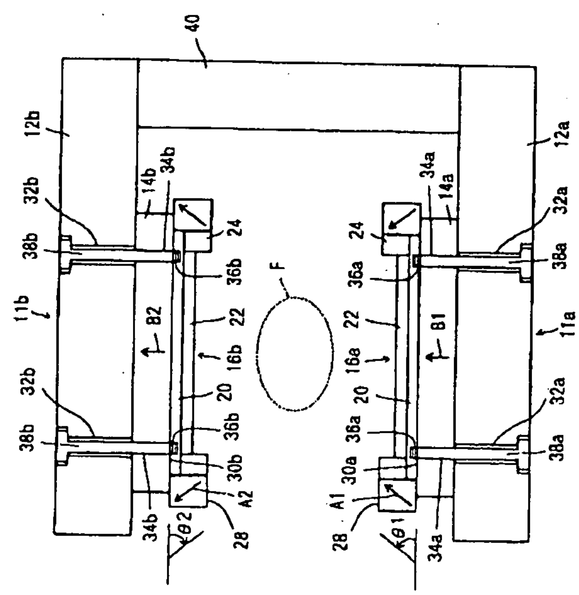
(54)【発明の名称】　磁界発生装置およびその製造方法

(57)【要約】
【課題】　輸送後における磁界強度の低下および磁界均一性の悪化を抑制できる、磁界発生装置およびその製造方法を提供する。
【解決手段】　磁界発生装置１０は一対の板状継鉄１２ａ，１２ｂを含む。一対の板状継鉄１２ａ，１２ｂのそれぞれの対向面側には永久磁石群１４ａ，１４ｂが配置され、永久磁石群１４ａ，１４ｂのそれぞれの対向面側には磁極板１６ａ，１６ｂが固着される。永久磁石群１４ａ，１４ｂは永久磁石１８を含む。磁極板１６ａ，１６ｂは、環状突起２４と環状突起２４の外側面に設けられた漏洩磁束防止用の永久磁石２８とを含む。永久磁石１８，２８は、着磁率が８０％以上９９．９％以下のＲ－Ｆｅ－Ｂ系磁石を含む。製造時には、組み立てられた磁界発生装置１０全体を４０℃以上７０℃以下で加温する。



【特許請求の範囲】

【請求項１】　空隙を形成して対向配置されかつＲ－Ｆｅ－Ｂ系磁石を含む一対の第１磁石、および前記一対の第１磁石を支持する継鉄を備え、
前記Ｒ－Ｆｅ－Ｂ系磁石の着磁率が８０％以上９９．９％以下である、磁界発生装置。

【請求項２】　前記一対の第１磁石の対向面側に設けられる磁極板をさらに備え、
前記磁極板は、環状突起と前記環状突起の外側面に設けられた漏洩磁束防止用の第２磁石とを含む、請求項１に記載の磁界発生装置。

【請求項３】　前記Ｒ－Ｆｅ－Ｂ系磁石は、Ｃｏおよび／またはＤｙを実質的に含まない、請求項１または２に記載の磁界発生装置。

【請求項４】　必要とされる磁界強度の均一度が１００ｐｐｍ以内である、請求項１から３のいずれかに記載の磁界発生装置。

【請求項５】　コンテナで輸送される、請求項１から４のいずれかに記載の磁界発生装置。

【請求項６】　均一磁界空間において０．２５Ｔ以上の磁界強度を有する、請求項１から５のいずれかに記載の磁界発生装置。

【請求項７】　Ｒ－Ｆｅ－Ｂ系磁石を含む磁界発生装置を組み立てる第１工程、および組み立てられた前記磁界発生装置全体を４０℃以上７０℃以下で加温する第２工程を備える、磁界発生装置の製造方法。

【請求項８】　Ｒ－Ｆｅ－Ｂ系磁石を含む磁石を板状継鉄に固定し磁極ユニットを組み立てる第１工程、
組み立てられた前記磁極ユニットを４０℃以上７０℃以下で加温する第２工程、および加温された前記磁極ユニットを支持継鉄に固定する第３工程を備える、磁界発生装置の製造方法。

【請求項９】　Ｒ－Ｆｅ－Ｂ系磁石を含む磁石を形成する第１工程、
前記磁石を４０℃以上７０℃以下で加温する第２工程、
加温された前記磁石を着磁する第３工程、および着磁された前記磁石を板状継鉄に固定する第４工程を備える、磁界発生装置の製造方法。

【請求項１０】　Ｒ－Ｆｅ－Ｂ系磁石を含む磁石を形成する第１工程、
前記磁石を９９．９％をこえる着磁率で着磁する第２工程、
着磁された前記磁石を８０％以上９９．９％以下の着磁率に減磁させる第３工程、および減磁された前記磁石を板状継鉄に固定する第４工程を備える、磁界発生装置の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は磁界発生装置およびその製造方法に関し、より特定的にはＭＲＩ用磁界発生装置およびその製造方法に関する。

【０００２】

【従来の技術】従来、ＭＲＩ用の磁界発生装置は、出荷前に予め磁界強度および磁界均一性が十分に調整された上で、コンテナ等で設置場所まで輸送される。

【０００３】

【発明が解決しようとする課題】しかし、このような工夫にも拘わらず現地に到着した時点で磁界強度が低下しあるいは磁界の均一性が基準値を超えて悪化し、磁界発生装置を再調整しなければならない場合があった。特に、漏洩磁束防止用磁石を用いて漏洩磁束を少なくするとともに主磁石から発生した磁束を中心部分に集中させる磁界発生装置においてその傾向が顕著である。また、コンテナ梱包されて輸出される場合や、撮像スピードを向上させるために最近多く使用されている磁界強度の大きい（中心磁界強度：０．２５Ｔ以上）装置においてもその傾向が顕著である。それゆえにこの発明の主たる目的は、輸送後における磁界強度の低下および磁界均一性の悪化を抑制できる、磁界発生装置およびその製造方法を提供することである。

【０００４】

【課題を解決するための手段】上述の目的を達成するために、請求項１に記載の磁界発生装置は、空隙を形成して対向配置されかつＲ－Ｆｅ－Ｂ系磁石を含む一対の第１磁石、および一対の第１磁石を支持する継鉄を備え、Ｒ－Ｆｅ－Ｂ系磁石の着磁率が８０％以上９９．９％以下であることを特徴とする。この明細書において「着磁率」とは常温（２５℃）における着磁率をいう。請求項２に記載の磁界発生装置は、請求項１に記載の磁界発生装置において、一対の第１磁石の対向面側に設けられる磁極板をさらに備え、磁極板は、環状突起と環状突起の外側面に設けられた漏洩磁束防止用の第２磁石とを含むことを特徴とする。

【０００５】請求項３に記載の磁界発生装置は、請求項１または２に記載の磁界発生装置において、Ｒ－Ｆｅ－Ｂ系磁石は、Ｃｏおよび／またはＤｙを実質的に含まないことを特徴とする。請求項４に記載の磁界発生装置は、請求項１から３のいずれかに記載の磁界発生装置において、必要とされる磁界強度の均一度が１００ｐｐｍ以内（均一磁界空間において空間内の各ポイントが中心磁界強度（基準磁界強度）に対して±５０ｐｐｍの磁界強度を有する）であることを特徴とする。

【０００６】請求項５に記載の磁界発生装置は、請求項１から４のいずれかに記載の磁界発生装置において、コンテナで輸送されることを特徴とする。請求項６に記載の磁界発生装置は、請求項１から５のいずれかに記載の磁界発生装置において、均一磁界空間において０．２５Ｔ以上の磁界強度を有することを特徴とする。

【０００７】請求項７に記載の磁界発生装置の製造方法は、Ｒ－Ｆｅ－Ｂ系磁石を含む磁界発生装置を組み立て

る第１工程、および組み立てられた磁界発生装置全体を４０℃以上７０℃以下で加温する第２工程を備える。請求項８に記載の磁界発生装置の製造方法は、Ｒ－Ｆｅ－Ｂ系磁石を含む磁石を板状継鉄に固定し磁極ユニットを組み立てる第１工程、組み立てられた磁極ユニットを４０℃以上７０℃以下で加温する第２工程、および加温された磁極ユニットを支持継鉄に固定する第３工程を備える。

【０００８】請求項９に記載の磁界発生装置の製造方法は、Ｒ－Ｆｅ－Ｂ系磁石を含む磁石を形成する第１工程、磁石を４０℃以上７０℃以下で加温する第２工程、加温された磁石を着磁する第３工程、および着磁された磁石を板状継鉄に固定する第４工程を備える。請求項１０に記載の磁界発生装置の製造方法は、Ｒ－Ｆｅ－Ｂ系磁石を含む磁石を形成する第１工程、磁石を９９．９％をこえる着磁率で着磁する第２工程、着磁された磁石を８０％以上９９．９％以下の着磁率に減磁させる第３工程、および減磁された磁石を板状継鉄に固定する第４工程を備える。

【０００９】請求項１に記載の磁界発生装置では、Ｒ－Ｆｅ－Ｂ系磁石（Ｒはイットリウム（Ｙ）を含む希土類元素、Ｆｅは鉄、Ｂはホウ素）の最終的な着磁率を８０％以上９９．９％以下に抑制することによって、固有保磁力を損なわずに組み立てられた磁界発生装置の経時的なあるいは温度上昇等の環境要因による減磁を抑制できる。したがって、磁界発生装置の輸送後における磁界強度の低下および磁界均一度の悪化を抑制でき、磁界発生装置は設置場所に到着した時点で高い磁界均一度を保つことができる。

【００１０】なお、Ｒ－Ｆｅ－Ｂ系磁石の最終的な着磁率が８０％未満であれば、当該磁石の磁気特性を十分に生かすことができず、磁石使用量が多くなり効率が悪くなる。一方、その最終的な着磁率が９９．９％を超えた状態で当該磁石を使用すると、輸送時の温度変化等によって当該磁石の減磁が大きくなってしまう。

【００１１】一般に、漏洩磁束防止用の第２磁石を設けることによって、漏洩磁束を少なくすることはできるがその反面、主磁石である第１磁石を減磁させ易くなる。請求項２に記載の磁界発生装置では、第１磁石に含まれるＲ－Ｆｅ－Ｂ系磁石の着磁率を予め抑えておくことによって、漏洩磁束防止用の第２磁石をさらに設けても第１磁石は第２磁石の影響をさほど受けず、磁界発生装置の磁界強度の変化および磁界均一度の悪化を抑制できる。また、漏洩磁束防止用の第２磁石を組み付けてから磁界発生装置に加温処理を施せば、その後の磁界強度の変化や磁界均一度の悪化を一層抑制できる。

【００１２】Ｒ－Ｆｅ－Ｂ系磁石は、コバルト（Ｃｏ）やディスプロシウム（Ｄｙ）を含まないと固有保磁力が小さくなり熱減磁が発生しやすく逆磁界に対して弱くなり、それぞれの場合磁界強度や磁界均一度が変化しやすくなる。しかし、請求項３に記載の磁界発生装置では、予めＲ－Ｆｅ－Ｂ系磁石の最終的な着磁率を抑えておくことによって、高価な元素であるＣｏやＤｙを含まない磁石を用いても磁界強度の変化および磁界均一度の悪化を抑制できる。なお、請求項３において「実質的に含まない」とは、重量比率で０．１ｗｔ％以下であることをいう。

【００１３】請求項４に記載の磁界発生装置では、磁界強度の変化や磁界均一度の悪化を抑制できるので、誤差が１００ｐｐｍ以内という高精度の磁界強度が必要とされる場合であっても、磁界強度の誤差を上述の範囲内に抑えやすい。

【００１４】たとえば空調を行っていないコンテナで磁界発生装置を輸送する場合には、コンテナ内の温度が７０℃前後まで上昇する場合もあるため、磁界強度の変化および磁界均一度の悪化を招き易い。請求項５に記載の磁界発生装置では、このようなコンテナによって輸送される場合であっても磁界強度の変化および磁界均一度の悪化を抑制できる。

【００１５】減磁は％単位で発生するので磁界強度が大きいほど磁界強度の変化量は大きくなる。したがって、均一磁界空間の磁界強度がたとえば０．２５Ｔ以上と大きい場合には、磁界強度の変化量も大きくなる。請求項６に記載の磁界発生装置では、このように磁界強度が大きい場合であっても、磁界強度の変化を抑制できる。「均一磁界空間」とは、磁界強度の差が１００ｐｐｍ以内である磁界空間をいう。

【００１６】請求項７に記載の磁界発生装置の製造方法では、着磁率が９９．９％をこえる磁石を使用して磁界発生装置を組み立てた後に磁界発生装置全体を加温することによって、磁界発生装置に含まれる磁石を予め減磁し着磁率を抑えておく。これによって、たとえば温度上昇等の環境要因の変化があっても磁界発生装置によって発生する磁界が長時間にわたって安定し、磁界発生装置の輸送後における磁界強度の低下および磁界均一度の悪化を抑制でき、磁界発生装置は設置場所に到着した時点で高い磁界精度を保つことができる。

【００１７】請求項８に記載の磁界発生装置の製造方法では、磁極ユニットの組立後に磁極ユニット全体を加温することによって、磁極ユニットに含まれる磁石を予め減磁し着磁率を抑えておく。この磁極ユニットを用いて組み立てられた磁界発生装置では、磁界が長時間にわたって安定し、磁界発生装置の輸送後における磁界強度の低下および磁界均一度の悪化を抑制できる。また、磁界発生装置全体を加温する場合より加温スペースが狭くて足りる。

【００１８】請求項９に記載の磁界発生装置の製造方法では、磁石の段階で加温してから着磁することによって磁石の着磁率を抑えておく。この磁石を用いて組み立てられた磁界発生装置では、磁界が長時間にわたって安定

し、磁界発生装置の輸送後における磁界強度の低下および磁界均一度の悪化を抑制できる。また、磁界発生装置全体や磁極ユニットを加温する場合より、加温スペースが狭くてもよく、小型の加温装置を用いることができる。

【００１９】請求項１０に記載の磁界発生装置の製造方法では、磁石を９９．９％をこえる着磁率で着磁してから減磁することによって磁石の着磁率を抑えておく。この磁石を用いて組み立てられた磁界発生装置では、磁界が長時間にわたって安定し、磁界発生装置の輸送後における磁界強度の低下および磁界均一度の悪化を抑制できる。また、磁石の状態で処理できるので作業効率がよい。

【００２０】

【発明の実施の形態】以下、図面を参照してこの発明の実施形態について説明する。図１および図２を参照して、この発明の一実施形態のＭＲＩ用磁界発生装置１０は、オープンタイプのＭＲＩ用磁界発生装置であり、空隙を形成して対向配置される一対の磁極ユニット１１ａおよび１１ｂを含む。

【００２１】磁極ユニット１１ａおよび１１ｂは、それぞれ板状継鉄１２ａおよび１２ｂを含む。一対の板状継鉄１２ａおよび１２ｂのそれぞれの対向面側には永久磁石群１４ａおよび１４ｂが配置され、永久磁石群１４ａおよび１４ｂのそれぞれの対向面側には磁極板１６ａおよび１６ｂが固着される。

【００２２】永久磁石群１４ａおよび１４ｂは、図３からわかるように、直方体状の複数の永久磁石１８を含む。永久磁石１８には、たとえばＮＥＯＭＡＸ－４７（住友特殊金属株式会社製）等のＣｏおよび／またはＤｙが実質的に含まれていない高磁束密度タイプのＲ－Ｆｅ－Ｂ系磁石が用いられ、たとえば常温における着磁率は８０％以上９９．９％以下に設定される。一例として、永久磁石１８は、着磁率１００％のときの磁束密度が０．３８２４Ｔの磁石であれば、磁束密度が０．３８２０Ｔとなるよう着磁される。永久磁石１８は図示しない磁石単体を組み立てることによって得られる。

【００２３】磁極板１６ａは、永久磁石群１４ａ上に配置されるたとえば鉄からなる円板状のベースプレート２０を含む。ベースプレート２０上には、うず電流の発生を防止するための珪素鋼板２２が形成される。珪素鋼板２２は、ベースプレート２０上に接着剤で固定される。ベースプレート２０の周縁部には、たとえば鉄からなり周縁部の磁界強度を上げ、均一磁界を得るための環状突起２４が形成される。環状突起２４は複数の環状突起片２６を含み、各環状突起片２６を珪素鋼板２２の周縁部に固定することによって環状突起２４が形成される。

【００２４】各環状突起２４の外側面には、漏洩磁束防止用の永久磁石２８が設けられる。永久磁石２８には、ＮＥＯＭＡＸ－３９ＳＨ（住友特殊金属株式会社製）等

の高保磁力タイプのＲ－Ｆｅ－Ｂ系磁石が用いられ、たとえば常温における着磁率は８０％以上９９．９％以下に設定される。一例として、永久磁石２８は、着磁率１００％のときの磁束密度が０．３８２４Ｔの磁石であれば、磁束密度が０．３８２０Ｔとなるよう着磁される。永久磁石２８は図示しない磁石単体を組み立てることによって得られる。

【００２５】永久磁石２８によって磁束を磁極板１６ａ、１６ｂ間に誘導し漏れ磁束を少なくできる。永久磁石２８の底部から磁束が漏洩しないように、永久磁石２８の底部が永久磁石群１４ａに略当接（５ｍｍ以下に近接）するまで、永久磁石２８の下部が延びていることが望ましい。このように永久磁石２８と永久磁石群１４ａとが近接する場合には減磁が発生しやすい。磁極板１６ｂについても同様である。

【００２６】図２に示すように、下側の磁極板１６ａにおける永久磁石２８の磁化方向Ａ１は永久磁石群１４ａの各永久磁石１８の磁化方向Ｂ１とは異なり内向きとなる。その永久磁石２８の磁化角度θ１は永久磁石群１４ａの主面３０ａ（水平方向）に対して永久磁石２８の磁化方向Ａ１がなす角度を示す。上側の磁極板１６ｂにおける永久磁石２８の磁化方向Ａ２は永久磁石群１４ｂの各永久磁石１８の磁化方向Ｂ２とは異なり外向きとなる。その永久磁石２８の磁化角度θ２は永久磁石群１４ｂの主面３０ｂ（水平方向）に対して永久磁石２８の磁化方向Ａ２がなす角度を示す。

【００２７】また、板状継鉄１２ａおよび１２ｂには、それぞれ複数の貫通孔３２ａおよび３２ｂが形成され、永久磁石群１４ａおよび１４ｂには、それぞれ貫通孔３２ａおよび３２ｂに対応する位置に貫通孔３４ａおよび３４ｂが形成される。さらに、磁極板１６ａおよび１６ｂの各ベースプレート２０には、それぞれ貫通孔３４ａおよび３４ｂに対応する位置にねじ孔３６ａおよび３６ｂが形成される。

【００２８】そして、磁極板固定用の固定ボルト３８ａが、貫通孔３２ａおよび３４ａに挿通され、すなわち板状継鉄１２ａおよび永久磁石群１４ａを貫通して、ねじ孔３６ａに螺入されることによって、磁極板１６ａが永久磁石群１４ａの主面に固定される。同様に、磁極板固定用の固定ボルト３８ｂが、貫通孔３２ｂおよび３４ｂに挿通され、すなわち板状継鉄１２ｂおよび永久磁石群１４ｂを貫通して、ねじ孔３６ｂに螺入されることによって、磁極板１６ｂが永久磁石群１４ｂの主面に固定される。

【００２９】板状継鉄１２ａおよび１２ｂは一枚の板状の支持継鉄４０によって磁気的に結合される。すなわち、支持継鉄４０の下端面に板状継鉄１２ａの一端縁側上面が、支持継鉄４０の上端面が板状継鉄１２ｂの一端縁側下面にそれぞれ位置するように、支持継鉄４０が板状継鉄１２ａおよび１２ｂに接続される。したがって、

板状継鉄１２ａおよび１２ｂと支持継鉄４０とは、その接続部が略９０度の角度を有し側面視コ字状になるように接続される。

【００３０】図１を参照して、板状継鉄１２ａと支持継鉄４０との接続部内面側のうち永久磁石群１４ａから最も遠い位置（この実施の形態では板状継鉄１２ａと支持継鉄４０との接続部内面側の両端）に、それぞれ補強部材４２が形成される。同様に、板状継鉄１２ｂと支持継鉄４０との接続部内面側のうち永久磁石群１４ｂから最も遠い位置（この実施の形態では板状継鉄１２ｂと支持継鉄４０との接続部内面側の両端）に、それぞれ補強部材４２が形成される。したがって、補強部材４２によって、板状継鉄１２ａと支持継鉄４０とが、板状継鉄１２ｂと支持継鉄４０とがそれぞれより強く固定される。

【００３１】また、板状継鉄１２ａの下面には、４つの脚部４４が取り付けられる。このような磁界発生装置１０では、均一磁界空間Ｆ（図２参照）においてたとえば０．２５Ｔ以上の磁界強度が要求される。

【００３２】ついで、磁界発生装置１０の製造方法について説明する。なお、主磁石である永久磁石１８および漏洩磁束防止用磁石である永久磁石２８は、たとえば図４に示すような着磁装置５０を用いて着磁あるいは減磁される。着磁装置５０は着磁コイル５２を含み、載置台５４上に配置された永久磁石１８または２８が着磁コイル５２内に挿入される。着磁コイル５２には切り替えスイッチ５６を介して着磁電源５８が接続される。したがって、着磁装置５０は、切り替えスイッチ５６の動作によって着磁と減磁とを切り替えることができる。

【００３３】また、永久磁石１８および２８は、たとえば図５に示す加温装置６０を用いて加温される。加温装置６０は、加温槽６２を含み、加温槽６２内の上部および下部にはそれぞれヒータ６４が設けられる。ヒータ６４は温度制御装置６６によって制御される。また、永久磁石１８および２８は加温槽６２の入口から出口までコンベア６８によって搬送される。永久磁石１８（２８）は加温槽６２内で所定温度まで昇温される。

【００３４】（製造方法１）磁界発生装置１０全体を加温する場合について説明する。まず、磁界発生装置１０全体を組み立てる。このとき、永久磁石１８および２８はたとえば図４に示す着磁装置５０を用いて９９．９％をこえる着磁率で着磁されている。ここで、「着磁率が９９．９％をこえる着磁」とは、磁化が略飽和した状態をいい、通常、磁石の保磁力の３倍以上の磁界を印加したときにこの状態になる。

【００３５】そして、磁界発生装置１０を収容できる部屋をヒータによって全体が均一の温度になるように暖め、その部屋に磁界発生装置１０を収容して加温し減磁する。磁界発生装置１０はたとえば４０℃以上７０℃以下の所望の温度に加温される。この温度範囲であれば、永久磁石１８や２８の常温における着磁率を８０％以上

９９．９％以下に設定でき、所望の着磁率に応じて温度が設定される。その後、最終磁界調整を行う。

【００３６】この製造方法では、磁界発生装置１０全体を組み立ててから加温処理して永久磁石１８，２８の着磁率を８０％以上９９．９％以下に抑えることによって、その後における経時的なあるいは温度上昇による減磁を少なくでき、磁界発生装置１０の輸送後における磁界強度の低下および磁界均一度の悪化を抑制できる。

【００３７】特に、漏洩磁束防止用の永久磁石２８は主磁石である永久磁石１８を減磁させやすいが、この方法によれば、永久磁石１８および２８を含む磁界発生装置１０を加温して永久磁石１８および２８を減磁した後に最終磁界調整するので、その後における磁界均一度の劣化が少なく、漏洩磁束防止用の永久磁石２８による影響をも抑制できる。

【００３８】したがって、磁界発生装置１０は搬送中に高い温度になったとしても設置場所に到着した時点で高い磁界均一度を保つことができる。なお、磁界発生装置１０を加温するには、板状継鉄１２ａおよび１２ｂ等にヒータを埋め込んでおき、これによって磁界発生装置１０を内部から昇温させてもよい。この場合には、磁界発生装置１０全体をスポンジ等の断熱材で覆うことが好ましい。

【００３９】（製造方法２）磁極ユニット１１ａを加温する場合について説明する。まず、磁極ユニット１１ａを組み立てる。このとき、永久磁石１８および２８はたとえば図４に示す着磁装置５０を用いて９９．９％をこえる着磁率で着磁されている。

【００４０】そして、磁極ユニット１１ａを収容できる部屋をヒータによって全体が均一になるように暖め、その部屋に磁極ユニット１１ａを入れて加温し減磁する。磁極ユニット１１ａは、先の製造方法１と同様に所望の着磁率（８０％以上９９．９％以下から選択）に応じて、たとえば４０℃以上７０℃以下の温度に加温される。磁極ユニット１１ｂについても同様に処理する。その後、磁極ユニット１１ａ，１１ｂを支持継鉄４０に固定して磁界発生装置１０を得た後、工場出荷前に最終的に磁界均一度の調整を行う。

【００４１】この製造方法では、組み立てられた磁極ユニット１１ａ，１１ｂを加温処理することによって、磁極ユニット１１ａ，１１ｂを用いた磁界発生装置の輸送後における磁界強度の低下および磁界均一度の悪化を抑制できる。特に、漏洩磁束防止用の永久磁石２８は主磁石である永久磁石１８に影響を与えやすいが、この方法によれば、永久磁石１８および２８を含む磁極ユニットを加温して永久磁石１８および２８を減磁した後に最終磁界調整するので、その後における磁界均一度の劣化が少なく、漏洩磁束防止用の永久磁石２８による影響をも抑制できる。また、磁界発生装置１０全体を組み立ててから加温する場合と比べて加温スペースが狭くてもよ

い。

【００４２】（製造方法３）永久磁石１８を組み立て、昇温したあとで着磁する場合について説明する。この場合、永久磁石１８を組み立てた後、板状継鉄１２ａ，１２ｂに接着する前に以下の工程を行う。

【００４３】まず、永久磁石１８をたとえば図５に示す加温装置６０の加温槽６２内に入れ、永久磁石１８全体が均一にたとえば６０℃になるまで加温する。なお、永久磁石１８は、たとえば４０℃以上７０℃以下の所望の温度で加温され得る。加温された永久磁石１８を加温槽６２から取りだし、たとえば図４に示す着磁装置５０で永久磁石１８に対して瞬間的に高い磁界（３Ｔ以上）を印加し永久磁石１８を８０％以上９９．９％以下の着磁率で着磁する。高温時には低温時に比べて着磁率が低下するので、永久磁石１８を高温にした状態で着磁することは、結果的に、永久磁石１８を着磁後に熱減磁する（後述の製造方法５参照）のと同様になる。永久磁石２８についても同様に処理される。

【００４４】その後、永久磁石１８および２８を板状継鉄１２ａ，１２ｂに固定し、磁界発生装置１０を組み立てる。この製造方法によって得られた永久磁石１８および２８を用いた磁界発生装置１０では、輸送後における磁界強度の低下および磁界均一度の悪化を抑制できる。また、磁界発生装置１０全体や磁極ユニット１１ａ，１１ｂを加温する場合より、加温スペースが狭くてもよく、小型の加温装置６０を用いることができる。なお、永久磁石は一旦着磁すると磁力が働き吸引力や反発力が作用するので、加温した永久磁石を板状継鉄１２ａ，１２ｂに固定する分だけ順次着磁して使用することが、安全面から好ましい。

【００４５】（製造方法４）永久磁石１８を組み立て、着磁したあとで逆磁界を印加して減磁する場合について説明する。この場合、永久磁石１８を組み立てた後、板状継鉄１２ａ，１２ｂに接着する前に以下の工程を行う。

【００４６】まず、永久磁石１８に対して瞬間的に高い磁界（３Ｔ以上）を印加し９９．９％をこえる着磁率で着磁した後、着磁された永久磁石１８に対して逆磁界（０．０１Ｔ～２Ｔ）を印加して減磁させ、着磁率を８０％以上９９．９％以下に抑える。永久磁石１８の着磁および減磁は、たとえば図４に示す着磁装置５０を用いて行われる。永久磁石２８についても同様に処理される。

【００４７】その後、永久磁石１８および２８を板状継鉄１２ａ，１２ｂに固定し、磁界発生装置１０を組み立てる。この製造方法によって得られた永久磁石１８および２８を用いた磁界発生装置１０では、輸送後における磁界強度の低下および磁界均一度の悪化を抑制できる。また、この方法によれば、加温による減磁ではないので、時間が短くて済み、作業効率がよい。

【００４８】（製造方法５）永久磁石１８を組み立て、着磁したあとで熱減磁する場合について説明する。この場合、永久磁石１８を組み立てた後、板状継鉄１２ａ，１２ｂに接着する前に以下の工程を行う。

【００４９】まず、たとえば図４に示す着磁装置５０を用いて永久磁石１８に対して瞬間的に高い磁界（３Ｔ以上）を印加して９９．９％をこえる着磁率で着磁する。着磁された永久磁石１８をヒータが設置された炉内（４０℃～７０℃）内に収容して熱減磁させ、着磁率を８０％以上９９．９％以下に抑える。永久磁石２８についても同様に処理される。

【００５０】永久磁石１８および２８を板状継鉄１２ａ，１２ｂに固定し、磁界発生装置１０を組み立てる。この製造方法によって得られた永久磁石１８および２８を用いた磁界発生装置１０では、輸送後における磁界強度の低下および磁界均一度の悪化を抑制できる。

【００５１】なお、上述の製造方法以外の方法としては、永久磁石を本来の着磁方向とは逆方向にわずかに着磁した後に本着磁し所望の着磁率を得るようにしてもよい。この場合には、逆方向の着磁率が大きいほどその後の正方向の着磁磁界を大きくしなければならない。また、減磁の方法としては、磁界発生装置１０全体あるいは磁極ユニット１１ａ，１１ｂ全体に対して、逆磁界減磁を施すようにしてもよい。

【００５２】因みに、図６を参照して、永久磁石に関する一実験例について説明する。ここでは、永久磁石としてＮＥＯＭＡＸ－４７を用い、永久磁石を加温処理（１００％着磁した後５０℃で２４時間維持）した場合と加温処理しない場合とについて、磁界強度の経時変化を比較した。

【００５３】加温処理した永久磁石の着磁率は９９％、加温処理しない永久磁石の着磁率は１００％に設定された。そして、実験中は、永久磁石には逆磁界なしで温度が３２℃に保たれた。図６からわかるように、加温処理した場合は加温処理しない場合より磁界強度の変化率を大幅に小さくできる。

【００５４】つぎに、図７を参照して、他の実験例について説明する。ここでは、永久磁石としてＮＥＯＭＡＸ－４７を用い、永久磁石を５５℃加温処理した場合と、逆磁界減磁処理した場合と、加温処理および逆磁界減磁処理のいずれも行わない場合とについて、温度上昇に対する磁界強度の変化を比較した。

【００５５】「５５℃加温処理」は、永久磁石を１００％着磁した後５５℃で２時間保ち着磁率を９９．９％とした。「逆磁界減磁処理」は、永久磁石を１００％着磁した後、表面磁界強度が５５℃加温処理の場合と同等になるように逆磁界を上げながら減磁した。

【００５６】図７からわかるように、５５℃加温処理した場合および逆磁界減磁処理した場合は、これらの処理をしない場合より、温度上昇に対する磁界強度変化率が

大幅に小さくなる。さらに、５５℃加温処理した場合は逆磁界減磁処理した場合より、温度上昇に対する磁界強度変化率が小さくなる。これは、加温処理は永久磁石全体に対して均一に作用するが、逆磁界減磁処理は逆磁界による減磁を永久磁石に対して均一に作用させにくいからである。

【００５７】図６および図７の結果より、加温処理あるいは逆磁界減磁処理した永久磁石を主磁石および／または漏洩磁束防止用磁石として用いれば、主磁石や漏洩磁束防止用磁石の経時変化あるいは温度上昇による減磁を抑制でき、磁界発生装置を組み立てた後の磁界強度の変化や磁界均一度の低下を抑制できる。

【００５８】さらに、図８に磁界発生装置の磁束分布を示す。図８（ａ）は、漏洩磁束防止用磁石を有する磁界発生装置の磁束分布を示し、図８（ｂ）は、漏洩磁束防止用磁石がない磁界発生装置の磁束分布を示す。なお、図８（ａ）の場合の中心磁界強度は０．２６２Ｔ、図８（ｂ）の場合の中心磁界強度は０．２１５Ｔであった。

【００５９】図８（ａ）と（ｂ）とを比較してわかるように、漏洩磁束防止用磁石を用いた場合には、磁束を磁極板間に誘導する一方、漏洩磁束防止用磁石の外側の磁束が疎になる。言い換えれば、漏洩磁束防止用磁石と永久磁石群とは互いに反発しあって減磁しやすい状態にあるといえる。したがって、漏洩磁束防止用磁石を用いた磁界発生装置では、温度が上昇することによって磁界強度やその分布がより変化しやすくなる。したがって、漏洩磁束防止用磁石を用いた磁界発生装置にこの発明を適用すれば、磁界均一度の劣化を抑制でき効果的である。

【００６０】また、永久磁石１８や２８に用いられるＲ－Ｆｅ－Ｂ系磁石は、フェライト磁石やＳｍ－Ｃｏ磁石に比べて比較的低温で熱減磁が発生しやすいが、上述の実施形態のようにＲ－Ｆｅ－Ｂ系磁石の着磁率を予め抑えておくことによって熱減磁を抑制できる。

【００６１】永久磁石１８に高い残留磁束密度が要求される場合には上述のようにＣｏを実質的に含まない三元系Ｒ－Ｆｅ－Ｂ系磁石が使用される。この場合には、Ｃｏを含む永久磁石に比べて熱減磁が大きくなるので、上述の実施形態を採用する効果が大きい。さらにＤｙを実質的に含んでいない磁石を用いる場合にも、上述の実施形態を採用する効果は大きい。

【００６２】また、磁界強度の変化や磁界均一度の悪化を抑制できるので、空隙において、均一磁界空間Ｆすなわち磁界強度の誤差が１００ｐｐｍ以内の磁界空間が必要とされる場合であっても、磁界強度の誤差を上述の範囲内に抑えやすい。さらに、たとえば空調が十分でないコンテナによって磁界発生装置が輸送される場合であっても、磁界強度の変化および磁界均一度の悪化を抑制できる。また、均一磁界空間Ｆの磁界強度がたとえば０．２５Ｔ以上と大きく変化量が大きくなりやすい場合であっても、磁界強度の変化を抑制できる。

【００６３】

【発明の効果】この発明によれば、組み立てられた磁界発生装置の経時的なあるいは温度上昇等の環境要因による減磁を抑制できる。したがって、磁界発生装置の輸送後における磁界強度の低下および磁界均一度の悪化を抑制でき、磁界発生装置は設置場所に到着した時点で高い磁界均一度を保つことができる。

【００６４】また、磁界発生装置の組立後に磁界発生装置全体を加温しておけば、温度上昇等の環境要因の変化があっても磁界発生装置によって発生する磁界が長時間にわたって安定し、磁界発生装置の輸送後における磁界強度の低下および磁界均一度の悪化を抑制できる。磁極ユニットを組み立てた後に加温する場合も同様に、磁界発生装置の輸送後における磁界強度の低下および磁界均一度の悪化を抑制できる。

【００６５】さらに、磁石の段階で加温してから着磁する場合も同様に、磁界発生装置の輸送後における磁界強度の低下および磁界均一度の悪化を抑制でき、また、加温処理には小型の加温装置を用いることができる。また、磁石を着磁してから減磁する場合も同様に、磁界発生装置の輸送後における磁界強度の低下および磁界均一度の悪化を抑制でき、さらに、磁石の状態で処理できるので作業効率が向上する。

【図面の簡単な説明】

【図１】この発明の一実施形態を示す斜視図である。

【図２】図１の実施形態の要部を示す図解図である。

【図３】この発明に用いられる永久磁石群の一例を示す斜視図である。

【図４】この発明に用いられる着磁装置の一例を示す図解図である。

【図５】この発明に用いられる加温装置の一例を示す図解図である。

【図６】永久磁石の磁界強度の経時変化を示すグラフである。

【図７】永久磁石の磁界強度の温度上昇による変化を示すグラフである。

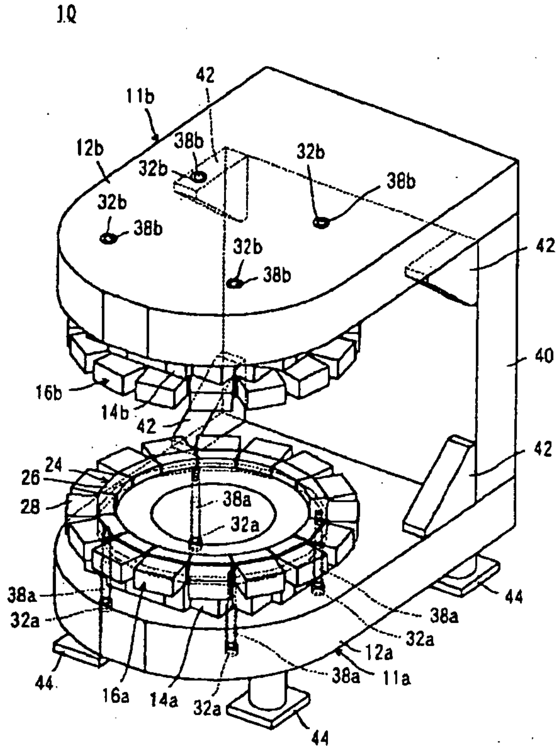
【図８】（ａ）は漏洩磁束防止用磁石を有する磁界発生装置の磁束分布、（ｂ）は漏洩磁束防止用磁石のない磁界発生装置の磁束分布を示す。

【符号の説明】

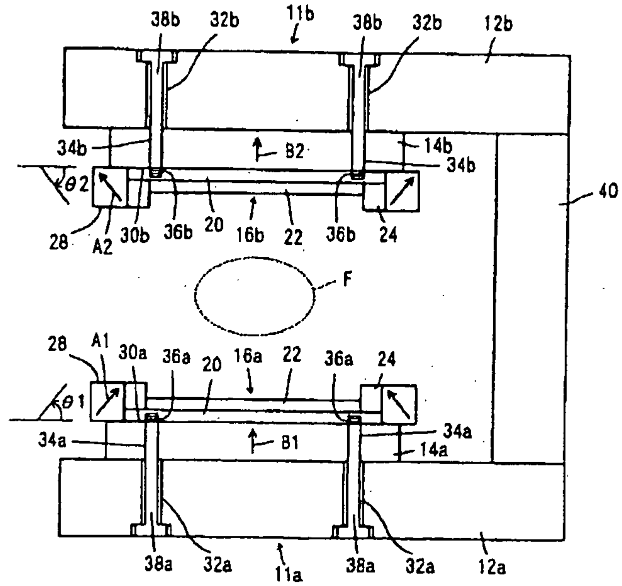
１０　磁界発生装置
１１ａ，１１ｂ　磁極ユニット
１２ａ，１２ｂ　板状継鉄
１４ａ，１４ｂ　永久磁石群
１６ａ，１６ｂ　磁極板
１８，２８　永久磁石
２４　環状突起
４０　支持継鉄
５０　着磁装置
６０　加温装置

F　　均一磁界空間

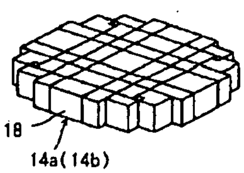
【図１】



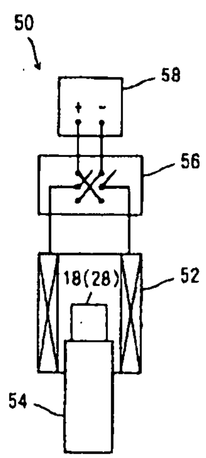
【図２】



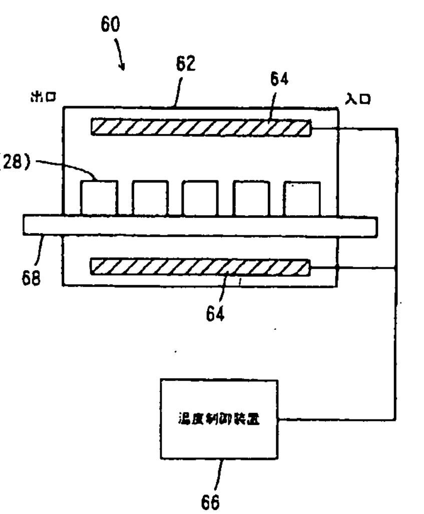
【図３】



【図４】



【図５】



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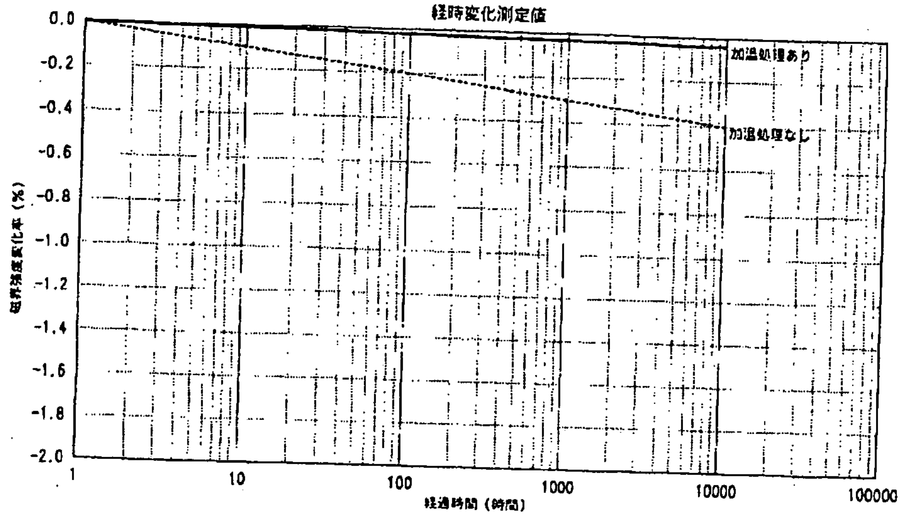
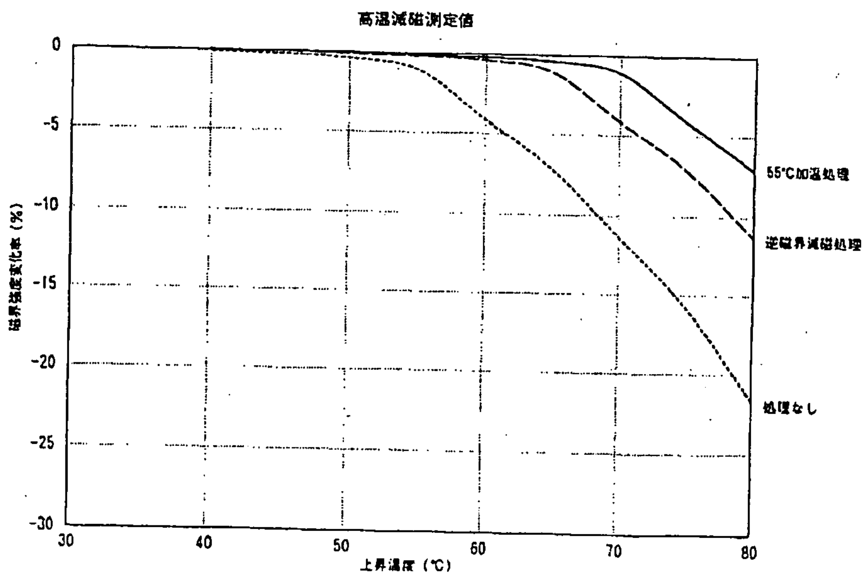
【図６】

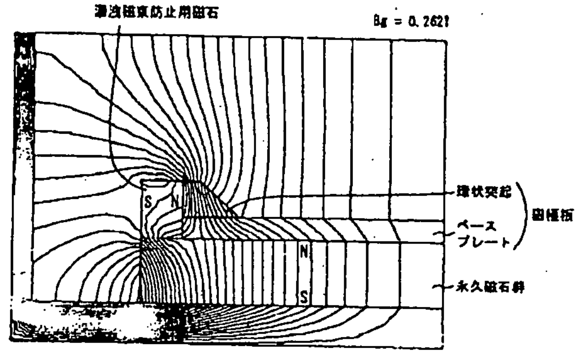

経時変化測定値
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
磁界強度変化率（%）
1
10
100
1000
10000
100000
経過時間（時間）
加温処理あり
加温処理なし

【図７】

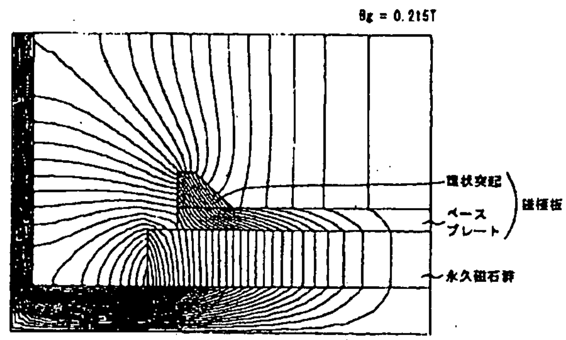

高温減磁測定値
0
-5
-10
-15
-20
-25
-30
磁界強度変化率（%）
30
40
50
60
70
80
上昇温度（℃）
55℃加温処理
逆磁界減磁処理
処理なし

【図８】

（a）


漏洩磁束防止用磁石
Bg = 0.262T
S
N
N
S
環状突起
ベース
プレート
磁極板
永久磁石群

（b）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環状突起
ベース
プレート
磁極板
永久磁石群

10/524314

DT01 Rec'd PCT/PTO 09 FEB 2005

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Bibliography

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(43) [Date of Publication] October 28, Heisei 15 (2003. 10.28)
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G01R 33/383
33/389
[FI]
A61B 5/05 331
G01N 24/06 510 P
530 Y
[Request for Examination] Un-asking.
[The number of claims] 10
[Mode of Application] OL
[Number of Pages] 10
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(33) [Country Declaring Priority] Japan (JP)
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[Patent Attorney]
[Name] Tatsumi Tadahiro
[Theme code (reference)]
4C096
[F term (reference)]
4C096 AB32 AB45 AD08 CA05 CA70

Epitome

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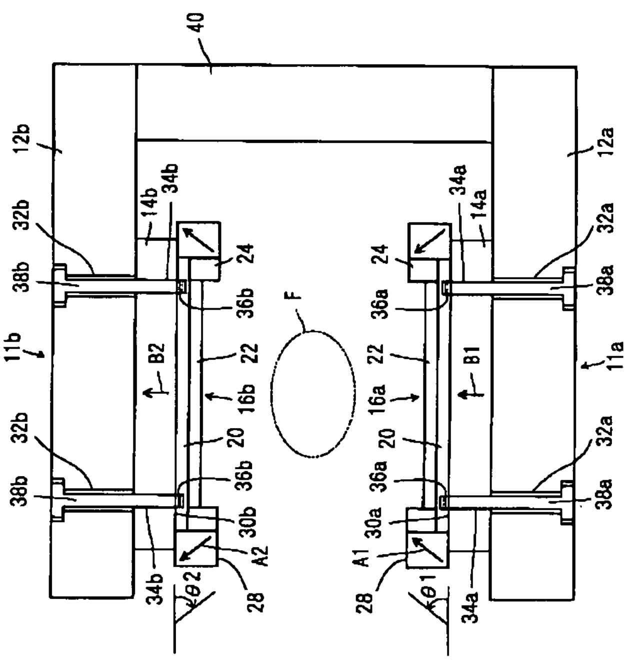
(57) [Abstract]
[Technical problem] The field generator which can control the fall of the magnetic field strength after transportation and aggravation of field homogeneity, and its manufacture approach are offered.
[Means for Solution] The field generator 10 contains the tabular yokes 12a and 12b of a pair. The permanent magnet groups 14a and 14b are arranged at each opposed face side of the tabular yokes 12a and 12b of a pair, and the magnetic pole plates 16a and 16b fix to each opposed face side of the permanent magnet groups 14a and 14b. The permanent magnet

groups 14a and 14b contain a permanent magnet 18. The magnetic pole plates 16a and 16b contain the permanent magnet 28 for magnetic-leakage-flux prevention prepared in the lateral surface of the annular projection 24 and the annular projection 24. As for permanent magnets 18 and 28, the rate of magnetization contains 99.9% or less of R-Fe-B system magnet 80% or more. At the time of manufacture, the field generator 10 assembled whole is warmed below 40 degrees C or more 70 degrees C.

[Translation done.]



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CLAIMS

[Claim(s)]
[Claim 1] The field generator whose rate of magnetization of said R-Fe-B system magnet it has the yoke which supports the 1st magnet of the pair which forms an opening, and opposite arrangement is carried out, and contains a R-Fe-B system magnet, and the 1st magnet of said pair, and is 99.9% or less 80% or more.
[Claim 2] It is the field generator according to claim 1 with which said magnetic pole plate contains the 2nd magnet for magnetic-leakage-flux prevention formed in the lateral surface of an annular projection and said annular projection by having further the magnetic pole plate formed in the opposed face side of the 1st magnet of said pair.
[Claim 3] Said R-Fe-B system magnet is a field generator according to claim 1 or 2 which does not contain Co and/or Dy substantially.
[Claim 4] A field generator given in either of claims 1-3 whose uniformity coefficient of the magnetic field strength needed is less than 100 ppm.
[Claim 5] A field generator given in either of claims 1-4 which is conveyed by container.
[Claim 6] A field generator given in either of claims 1-5 which has the magnetic field strength beyond 0.25T in homogeneity field space.
[Claim 7] The manufacture approach of a field generator equipped with the 1st process which assembles the field generator containing a R-Fe-B system magnet, and the 2nd process which warms said assembled whole field generator below 40 degrees C or more 70 degrees C.
[Claim 8] The manufacture approach of a field generator equipped with the 2nd process which warms said magnetic pole unit which fixes the magnet containing a R-Fe-B system magnet to a tabular yoke, and assembles a magnetic pole unit, and which was assembled the 1st process below 40 degrees C or more 70 degrees C, and the 3rd process which fixes said warmed magnetic pole unit to a support yoke.
[Claim 9] The manufacture approach of a field generator equipped with the 1st process which forms the magnet containing a R-Fe-B system magnet, the 3rd process which magnetizes said warmed magnet which warms said magnet below 40 degrees C or more 70 degrees C the 2nd process, and the 4th process which fixes said magnetized magnet to a tabular yoke.
[Claim 10] The manufacture approach of a field generator equipped with the 1st process which forms the magnet containing a R-Fe-B system magnet, the 3rd process which makes 99.9% or less of rate of magnetization demagnetize said magnetized magnet which magnetizes said magnet at the

rate of magnetization which surpasses 99.9% 80% or more the 2nd process, and the 4th process which fixes said demagnetized magnet to a tabular yoke.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the field generator for MRI, and its manufacture approach more specifically about a field generator and its manufacture approach.
[0002]
[Description of the Prior Art] Conventionally, the field generator for MRI is conveyed by the container etc. to an installation, after magnetic field strength and field homogeneity are fully beforehand adjusted before shipment.
[0003]
[Problem(s) to be Solved by the Invention] However, when it arrived in spite of such a device there, magnetic field strength fell, or the homogeneity of a field got worse exceeding the reference value, and there was a case where a field generator had to be readjusted. While lessening magnetic leakage flux especially using the magnet for magnetic-leakage-flux prevention, the inclination is remarkable in the field generator which centralizes the magnetic flux generated from the main magnet on a part for a core. Moreover, when container packing is carried out and it is exported, in order to raise image pick-up speed, the inclination is remarkable also in equipment with the large (main magnetic field strength: more than 0.25T) magnetic field strength used recently. [many] So, the main purpose of this invention is offering

the field generator which can control the fall of the magnetic field strength after transportation, and aggravation of field homogeneity, and its manufacture approach.

[0004]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, a field generator according to claim 1 is equipped with the yoke which supports the 1st magnet of the pair which forms an opening, and opposite arrangement is carried out, and contains a R-Fe-B system magnet, and the 1st magnet of a pair, and the rate of magnetization of a R-Fe-B system magnet is characterized by being 99.9% or less 80% or more. In this specification, "the rate of magnetization" means the rate of magnetization in ordinary temperature (25 degrees C). A field generator according to claim 2 is further equipped with the magnetic pole plate formed in the opposed face side of the 1st magnet of a pair in a field generator according to claim 1, and a magnetic pole plate is characterized by including the 2nd magnet for magnetic-leakage-flux prevention formed in the lateral surface of an annular projection and an annular projection.

[0005] A field generator according to claim 3 is characterized by a R-Fe-B system magnet not containing Co and/or Dy substantially in a field generator according to claim 1 or 2. A field generator according to claim 4 is characterized by the uniformity coefficient of the magnetic field strength needed for either of claims 1-3 in the field generator of a publication being less than (each point in space having the magnetic field strength of **50 ppm to main magnetic field strength (reference field reinforcement) in homogeneity field space) 100 ppm.

[0006] A field generator according to claim 5 is characterized by being conveyed to either of claims 1-4 by container in the field generator of a publication. A field generator according to claim 6 is characterized by having the magnetic field strength beyond 0.25T in homogeneity field space in a field generator given in either of claims 1-5.

[0007] The manufacture approach of a field generator according to claim 7 is equipped with the 1st process which assembles the field generator containing a R-Fe-B system magnet, and the 2nd process which warms the assembled whole field generator below 40 degrees C or more 70 degrees C. The manufacture approach of a field generator according to claim 8 is equipped with the 2nd process which warms the magnetic pole unit which fixes the magnet containing a R-Fe-B system magnet to a tabular yoke, and assembles a magnetic pole unit, and which was assembled the 1st process below 40 degrees C or more 70 degrees C, and the 3rd process which fixes the warmed magnetic pole unit to a support yoke.

[0008] The manufacture approach of a field generator according to claim 9 is equipped with the 1st process which forms the magnet containing a R-Fe-B system magnet, the 3rd process which magnetizes the warmed magnet which warms a magnet below 40 degrees C or more 70 degrees C the 2nd process, and the 4th process which fixes the magnetized magnet to a tabular yoke. The manufacture approach of a field generator according to claim 10 is equipped with the 1st process which forms the magnet containing a R-Fe-B system magnet, the 3rd process which makes 99.9% or less of rate of magnetization demagnetize the magnetized magnet which magnetizes a magnet at the rate of magnetization which surpasses 99.9% 80% or more the 2nd process, and the 4th process which fixes the demagnetized magnet to a tabular yoke.
[0009] the field generator assembled without spoiling proper coercive force is with time by controlling the final rate of magnetization of a R-Fe-B system magnet (for the rare earth elements in which R contains an yttrium (Y), and Fe, iron and B are boron) to 99.9% or less 80% or more in a field generator according to claim 1 -- it is -- it is -- demagnetization by environmental factors, such as a temperature rise, can be controlled. Therefore, the fall of the magnetic field strength after transportation of a field generator and aggravation of a field uniformity coefficient can be controlled, and when a field generator reaches an installation, it can maintain a high field uniformity coefficient.
[0010] In addition, if the final rate of magnetization of a R-Fe-B system magnet is less than 80%, the magnetic properties of the magnet concerned cannot fully be employed efficiently, but the amount of the magnet used will increase, and effectiveness will worsen. On the other hand, if the magnet concerned is used after the final rate of magnetization has exceeded 99.9%, demagnetization of the magnet concerned will become large by the temperature change at the time of transportation etc.
[0011] Generally magnetic leakage flux can be lessened by forming the 2nd magnet for magnetic-leakage-flux prevention, but on the other hand it becomes that it is easy to make the 1st magnet which is the main magnet demagnetize. In a field generator according to claim 2, by stopping beforehand the rate of magnetization of the R-Fe-B system magnet contained in the 1st magnet, even if it forms further the 2nd magnet for magnetic-leakage-flux prevention, the 1st magnet is not influenced so much of the 2nd magnet, but can control change of the magnetic field strength of a field generator, and aggravation of a field uniformity coefficient. moreover -- since the 2nd magnet for magnetic-

leakage-flux prevention is attached -- a field generator -- warming -- if it processes, change of subsequent magnetic field strength and aggravation of a field uniformity coefficient can be controlled further.

[0012] If a R-Fe-B system magnet does not contain cobalt (Co) and a dysprosium (Dy), proper coercive force will become small, heat demagnetization becomes being easy to generate weakly to an opposing magnetic field, and, in each case, magnetic field strength and a field uniformity coefficient become easy to change. However, in a field generator according to claim 3, by stopping the final rate of magnetization of a R-Fe-B system magnet beforehand, even if it uses the magnet which contains neither Co which is an expensive element, nor Dy, change of magnetic field strength and aggravation of a field uniformity coefficient can be controlled. In addition, in claim 3, it says that it is less than [0.1wt%] by the weight ratio with ″it does not contain substantially.″

[0013] In a field generator according to claim 4, since change of magnetic field strength and aggravation of a field uniformity coefficient can be controlled, even if it is the case where the highly precise magnetic field strength of less than 100 ppm in an error is needed, it is easy to suppress the error of magnetic field strength within the limits of above-mentioned.

[0014] For example, also when the container which is not air-conditioning conveys a field generator, and the temperature in a container rises till around 70 degrees C, for a certain reason, it is easy to cause change of magnetic field strength, and aggravation of a field uniformity coefficient. In a field generator according to claim 5, even if it is the case where it is conveyed by such container, change of magnetic field strength and aggravation of a field uniformity coefficient can be controlled.

[0015] The variation of magnetic field strength becomes large, so that magnetic field strength is large, since demagnetization is generated per %. Therefore, when the magnetic field strength of homogeneity field space is as large as more than 0.25T, the variation of magnetic field strength also becomes large. In a field generator according to claim 6, even if it is the case in this way that magnetic field strength is large, change of magnetic field strength can be controlled. As for ″homogeneity field space″, the difference of magnetic field strength says the field space which is less than 100 ppm.

[0016] By the manufacture approach of a field generator according to claim 7, after the rate of magnetization assembles a field generator using the magnet which surpasses 99.9%, by warming the whole field

generator, the magnet contained in a field generator is demagnetized beforehand, and the rate of magnetization is stopped. Even if there is change of environmental factors, such as a temperature rise, the field generated with a field generator is stabilized over a long time, by this, the fall of the magnetic field strength after transportation of a field generator and aggravation of a field uniformity coefficient can be controlled, and when a field generator reaches an installation, it can maintain a high field precision.

[0017] By the manufacture approach of a field generator according to claim 8, by warming the whole magnetic pole unit after the assembly of a magnetic pole unit, the magnet contained in a magnetic pole unit is demagnetized beforehand, and the rate of magnetization is stopped. In the field generator assembled using this magnetic pole unit, a field is stabilized over long duration and the fall of the magnetic field strength after transportation of a field generator and aggravation of a field uniformity coefficient can be controlled. moreover, the case where the whole field generator is warmed -- warming -- a tooth space is narrow and it is sufficient for it.

[0018] By the manufacture approach of a field generator according to claim 9, the magnetic rate of magnetization is stopped by magnetizing, after warming in a magnetic phase. In the field generator assembled using this magnet, a field is stabilized over long duration and the fall of the magnetic field strength after transportation of a field generator and aggravation of a field uniformity coefficient can be controlled. moreover, the case where the whole field generator and a magnetic pole unit are warmed -- warming -- warming narrow [a tooth space] and small -- equipment can be used.

[0019] By the manufacture approach of a field generator according to claim 10, the magnetic rate of magnetization is stopped by demagnetizing, after magnetizing a magnet at the rate of magnetization which surpasses 99.9%. In the field generator assembled using this magnet, a field is stabilized over long duration and the fall of the magnetic field strength after transportation of a field generator and aggravation of a field uniformity coefficient can be controlled. Moreover, since it can process in the state of a magnet, working efficiency is good.

[0020]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained with reference to a drawing. With reference to drawing 1 and drawing 2 , the field generator 10 for MRI of 1 operation gestalt of this invention is an opening type field generator for MRI, and contains the magnetic pole units 11a and 11b of the pair by which

forms an opening and opposite arrangement is carried out.
[0021] The magnetic pole units 11a and 11b contain the tabular yokes 12a and 12b, respectively. The permanent magnet groups 14a and 14b are arranged at each opposed face side of the tabular yokes 12a and 12b of a pair, and the magnetic pole plates 16a and 16b fix to each opposed face side of the permanent magnet groups 14a and 14b.
[0022] The permanent magnet groups 14a and 14b contain two or more rectangular parallelepiped-like permanent magnets 18 so that drawing 3 may show. The R-Fe-B system magnet of the high flux density type with which Co(es), such as NEOMAX-47 (Sumitomo Special Metals Co., Ltd. make), and/or Dy are not contained substantially is used for a permanent magnet 18, for example, the rate of magnetization in ordinary temperature is set up to 99.9% or less 80% or more. As an example, if the flux density at the time of 100% of rates of magnetization is the magnet which is 0.3824T, a permanent magnet 18 will be magnetized so that flux density may be set to 0.3820T. A permanent magnet 18 is obtained by assembling the magnet simple substance which is not illustrated.
[0023] Magnetic pole plate 16a contains the disc-like base plate 20 which is arranged on permanent magnet group 14a and which consists of iron, for example. On a base plate 20, the silicon steel 22 for preventing generating of the eddy current is formed. Silicon steel 22 is fixed with adhesives on a base plate 20. It consists of iron, the magnetic field strength of the periphery section is raised, and the annular projection 24 for acquiring a homogeneity field is formed in the periphery section of a base plate 20. When the annular projection 24 fixes each piece 26 of an annular projection to the periphery section of silicon steel 22 including two or more pieces 26 of an annular projection, the annular projection 24 is formed.
[0024] The permanent magnet 28 for magnetic-leakage-flux prevention is formed in the lateral surface of each annular projection 24. A R-Fe-B system magnet high coercive force type [, such as NEOMAX-39SH (Sumitomo Special Metals Co., Ltd. make),] is used for a permanent magnet 28, for example, the rate of magnetization in ordinary temperature is set up to 99.9% or less 80% or more. As an example, if the flux density at the time of 100% of rates of magnetization is the magnet which is 0.3824T, a permanent magnet 28 will be magnetized so that flux density may be set to 0.3820T. A permanent magnet 28 is obtained by assembling the magnet simple substance which is not illustrated.
[0025] With a permanent magnet 28, magnetic flux is guided between magnetic pole plate 16a and 16b, and leakage flux can be lessened. It is desirable to have prolonged the lower part of a permanent magnet 28

until the pars basilaris ossis occipitalis of a permanent magnet 28 carries out abbreviation contact (5mm or less is approached) to permanent magnet group 14a so that magnetic flux may not be revealed from the pars basilaris ossis occipitalis of a permanent magnet 28. Thus, when a permanent magnet 28 and permanent magnet group 14a approach, it is easy to generate demagnetization. The same is said of magnetic pole plate 16b.

[0026] As shown in drawing 2 , unlike the magnetization direction B1 of each permanent magnet 18 of permanent magnet group 14a, the magnetization direction A1 of the permanent magnet 28 in lower magnetic pole plate 16a serves as inside sense. The magnetization include angle theta 1 of the permanent magnet 28 shows the include angle which the magnetization direction A1 of a permanent magnet 28 makes to principal plane 30of permanent magnet group 14a a (horizontal direction). Unlike magnetization direction B-2 of each permanent magnet 18 of permanent magnet group 14b, the magnetization direction A2 of the permanent magnet 28 in upper magnetic pole plate 16b serves as outwardness. The magnetization include angle theta 2 of the permanent magnet 28 shows the include angle which the magnetization direction A2 of a permanent magnet 28 makes to principal plane 30of permanent magnet group 14b b (horizontal direction).

[0027] Moreover, two or more through tubes 32a and 32b are formed in the tabular yokes 12a and 12b, respectively, and through tubes 34a and 34b are formed in the location corresponding to through tubes 32a and 32b at the permanent magnet groups 14a and 14b, respectively. Furthermore, it ****s in the location corresponding to through tubes 34a and 34b, respectively, and Holes 36a and 36b are formed in each base plate 20 of the magnetic pole plates 16a and 16b.

[0028] And magnetic pole plate 16a is fixed to the principal plane of permanent magnet group 14a by inserting securing bolt 38a for magnetic pole plate immobilization in through tubes 32a and 34a, namely, penetrating tabular yoke 12a and permanent magnet group 14a, and thrusting it into **** hole 36a. Magnetic pole plate 16b is fixed to the principal plane of permanent magnet group 14b by similarly, inserting securing bolt 38b for magnetic pole plate immobilization in through tubes 32b and 34b, namely, penetrating tabular yoke 12b and permanent magnet group 14b, and thrusting it into **** hole 36b.

[0029] The tabular yokes 12a and 12b are magnetically combined by the tabular support yoke 40 of one sheet. That is, the support yoke 40 is connected to the tabular yokes 12a and 12b so that the end veranda top face of tabular yoke 12a may be located in the lower limit side of the

support yoke 40 and the upper limit side of the support yoke 40 may be located in the end veranda inferior surface of tongue of tabular yoke 12b, respectively. Therefore, the tabular yokes 12a and 12b and the support yoke 40 are connected so that the connection may have the include angle which are 90 abbreviation and may become side view KO character-like.

[0030] With reference to drawing 1 , the reinforcement member 42 is formed in the most distant location (at the gestalt of this operation, they are the both ends by the side of the connection circles side of tabular yoke 12a and the support yoke 40) from permanent magnet group 14a, respectively in by the side of the connection circles side of tabular yoke 12a and the support yoke 40. Similarly, the reinforcement member 42 is formed in the most distant location (at the gestalt of this operation, they are the both ends by the side of the connection circles side of tabular yoke 12b and the support yoke 40) from permanent magnet group 14b, respectively in by the side of the connection circles side of tabular yoke 12b and the support yoke 40. Therefore, tabular yoke 12b and the support yoke 40 are stronger respectively, and tabular yoke 12a and the support yoke 40 are fixed by the reinforcement member 42.

[0031] Moreover, the four legs 44 are attached in the inferior surface of tongue of tabular yoke 12a. Such a field generator 10 requires the magnetic field strength beyond 0.25T in the homogeneity field space F (refer to drawing 2).

[0032] Subsequently, the manufacture approach of the field generator 10 is explained. In addition, the permanent magnet 28 which is the permanent magnet 18 and the magnet for magnetic-leakage-flux prevention which are the main magnet is magnetized or demagnetized using magnetization equipment 50 as shown in drawing 4 . The permanent magnets 18 or 28 with which magnetization equipment 50 has been arranged on the installation base 54 including the magnetization coil 52 are inserted into the magnetization coil 52. The magnetization power source 58 is connected to the magnetization coil 52 through a changeover switch 56. Therefore, magnetization equipment 50 can change magnetization and demagnetization by actuation of a changeover switch 56.

[0033] moreover, warming which shows permanent magnets 18 and 28 to drawing 5 -- it is warmed using equipment 60. warming -- equipment 60 -- warming -- a tub 62 -- containing -- warming -- a heater 64 is formed in the upper part and the lower part in a tub 62, respectively. A heater 64 is controlled by the temperature controller 66. moreover, the permanent magnets 18 and 28 -- warming -- it is conveyed by conveyor 68 from the inlet port of a tub 62 to an outlet. a permanent magnet 18 (28) --

warming -- a temperature up is carried out to predetermined temperature within a tub 62.

[0034] (The manufacture approach 1) The case where the field generator 10 whole is warmed is explained. First, the field generator 10 whole is assembled. At this time, permanent magnets 18 and 28 are magnetized at the rate of magnetization which surpasses 99.9% using the magnetization equipment 50 shown in drawing 4 . Here, "magnetization which has a rate [good] of magnetization for 99.9%" will be in this condition, when the condition that magnetization carried out abbreviation saturation is said and the field of 3 times or more of magnetic coercive force is usually impressed.

[0035] And the room in which the field generator 10 can be held is heated so that the whole may become the temperature of homogeneity at a heater, and the field generator 10 is held, warmed and demagnetized in the room. The field generator 10 is warmed by the temperature of 40-degree-C or more request of 70 degrees C or less. If it is this temperature requirement, the rate of magnetization in a permanent magnet 18 or the ordinary temperature of 28 can be set up to 99.9% or less 80% or more, and temperature will be set up according to the desired rate of magnetization. Then, the last field adjustment is performed.

[0036] since the field generator 10 whole is assembled by this manufacture approach -- warming -- it can set after that by processing and stopping the rate of magnetization of permanent magnets 18 and 28 to 99.9% or less 80% or more -- with time -- it is -- it is -- demagnetization by the temperature rise can be lessened and the fall of the magnetic field strength after transportation of the field generator 10 and aggravation of a field uniformity coefficient can be controlled.

[0037] Although especially the permanent magnet 28 for magnetic-leakage-flux prevention tends to make the permanent magnet 18 which is the main magnet demagnetize, since according to this approach the last field adjustment is carried out after warming the field generator 10 containing permanent magnets 18 and 28 and demagnetizing permanent magnets 18 and 28, there is little degradation of the field uniformity coefficient which can be set after that, and it can also control the effect by the permanent magnet 28 for magnetic-leakage-flux prevention.

[0038] Therefore, even if the field generator 10 became temperature high during conveyance, when it reaches an installation, it can maintain a high field uniformity coefficient. In addition, in order to warm the field generator 10, the heater is embedded at the tabular yokes 12a and 12b etc., and the temperature up of the field generator 10 may be carried out from the interior by this. In this case, it is desirable to

cover the field generator 10 whole with heat insulators, such as sponge.

[0039] (The manufacture approach 2) The case where magnetic pole unit 11a is warmed is explained. First, magnetic pole unit 11a is assembled. At this time, permanent magnets 18 and 28 are magnetized at the rate of magnetization which surpasses 99.9% using the magnetization equipment 50 shown in drawing 4 .

[0040] And the room in which magnetic pole unit 11a can be held is heated so that the whole may become homogeneity at a heater, and magnetic pole unit 11a is put in, warmed and demagnetized in the room. Magnetic pole unit 11a is warmed by 40-degree-C or more temperature of 70 degrees C or less like the previous manufacture approach 1, corresponding to the desired rate of magnetization (from 99.9% or less to 80% or more selection). Magnetic pole unit 11b is processed similarly. Then, after fixing the magnetic pole units 11a and 11b to the support yoke 40 and obtaining the field generator 10, finally a field uniformity coefficient is adjusted before factory shipments.

[0041] the magnetic pole units 11a and 11b assembled by this manufacture approach -- warming -- the fall of the magnetic field strength after transportation of the field generator using the magnetic pole units 11a and 11b and aggravation of a field uniformity coefficient can be controlled by processing. Although especially the permanent magnet 28 for magnetic-leakage-flux prevention tends to affect the permanent magnet 18 which is the main magnet, since according to this approach the last field adjustment is carried out after warming the magnetic pole unit containing permanent magnets 18 and 28 and demagnetizing permanent magnets 18 and 28, there is little degradation of the field uniformity coefficient which can be set after that, and it can also control the effect by the permanent magnet 28 for magnetic-leakage-flux prevention. moreover, the case where it warms after assembling the field generator 10 whole -- comparing -- warming -- a tooth space may be narrow.

[0042] (The manufacture approach 3) A permanent magnet 18 is assembled and the case where it magnetizes after carrying out a temperature up is explained. In this case, after assembling a permanent magnet 18, the following processes are performed before pasting the tabular yokes 12a and 12b.

[0043] first, warming which shows a permanent magnet 18 to drawing 5 -- warming of equipment 60 -- it puts in in a tub 62, and it warms until the permanent magnet 18 whole becomes 60 degrees C to homogeneity. In addition, a permanent magnet 18 may be warmed at the temperature of 40-degree-C or more request of 70 degrees C or less. the warmed permanent magnet 18 -- warming -- it takes out from a tub 62, a momentarily high

field (more than 3T) is impressed to a permanent magnet 18 with the magnetization equipment 50 shown, for example in drawing 4 , and a permanent magnet 18 is magnetized at 99.9% or less of rate of magnetization 80% or more. Magnetizing a permanent magnet 18 in the condition of having made it the elevated temperature, since the rate of magnetization falls compared with the time of low temperature at the time of an elevated temperature becomes being the same as that of that which carries out heat demagnetization after magnetizing a permanent magnet 18 (the manufacture approach 5 below-mentioned reference) as a result. A permanent magnet 28 is processed similarly.

[0044] Then, permanent magnets 18 and 28 are fixed to the tabular yokes 12a and 12b, and the field generator 10 is assembled. In the field generator 10 using the permanent magnets 18 and 28 obtained by this manufacture approach, the fall of the magnetic field strength after transportation and aggravation of a field uniformity coefficient can be controlled. moreover, the case where the field generator 10 whole and the magnetic pole units 11a and 11b are warmed -- warming -- warming narrow [a tooth space] and small -- equipment 60 can be used. In addition, since magnetism will work and a suction force and repulsive force will act once it magnetizes, as for a permanent magnet, it is desirable from a safety aspect that only a part to fix to the tabular yokes 12a and 12b uses the warmed permanent magnet, carrying out sequential magnetization.

[0045] (The manufacture approach 4) A permanent magnet 18 is assembled, and after magnetizing, the case where an opposing magnetic field is impressed and demagnetized is explained. In this case, after assembling a permanent magnet 18, the following processes are performed before pasting the tabular yokes 12a and 12b.

[0046] First, after magnetizing at the rate of magnetization which impresses a momentarily high field (more than 3T) to a permanent magnet 18, and surpasses 99.9%, an opposing magnetic field (0.01T-2T) is made to impress and demagnetize to the magnetized permanent magnet 18, and the rate of magnetization is stopped to 99.9% or less 80% or more. Magnetization and demagnetization of a permanent magnet 18 are performed using the magnetization equipment 50 shown in drawing 4 . A permanent magnet 28 is processed similarly.

[0047] Then, permanent magnets 18 and 28 are fixed to the tabular yokes 12a and 12b, and the field generator 10 is assembled. In the field generator 10 using the permanent magnets 18 and 28 obtained by this manufacture approach, the fall of the magnetic field strength after transportation and aggravation of a field uniformity coefficient can be

controlled. Moreover, according to this approach, since it is not demagnetization by warming, time amount is short, and ends and working efficiency is good.

[0048] (The manufacture approach 5) A permanent magnet 18 is assembled, and after magnetizing, the case where heat demagnetization is carried out is explained. In this case, after assembling a permanent magnet 18, the following processes are performed before pasting the tabular yokes 12a and 12b.

[0049] First, it magnetizes at the rate of magnetization which impresses a momentarily high field (more than 3T) to a permanent magnet 18 using the magnetization equipment 50 shown, for example in drawing 4 , and surpasses 99.9%. The magnetized permanent magnet 18 is held in the inside of a furnace (40 degrees C - 70 degrees C) in which the heater was installed, heat demagnetization is carried out, and the rate of magnetization is stopped to 99.9% or less 80% or more. A permanent magnet 28 is processed similarly.

[0050] Permanent magnets 18 and 28 are fixed to the tabular yokes 12a and 12b, and the field generator 10 is assembled. In the field generator 10 using the permanent magnets 18 and 28 obtained by this manufacture approach, the fall of the magnetic field strength after transportation and aggravation of a field uniformity coefficient can be controlled.

[0051] In addition, after magnetizing a permanent magnet slightly to hard flow with the original magnetization direction, actual magnetization is carried out and you may make it obtain the desired rate of magnetization as approaches other than the above-mentioned manufacture approach. In this case, the magnetization field of the subsequent forward direction must be enlarged, so that the rate of magnetization of hard flow is large. Moreover, it may be made to give opposing magnetic field demagnetization as the approach of demagnetization to the field generator 10 whole or magnetic pole unit 11a, and the whole 11b.

[0052] Incidentally, with reference to drawing 6 , the example of 1 experiment about a permanent magnet is explained. here -- as a permanent magnet -- NEOMAX-47 -- using -- a permanent magnet -- warming -- the case where it processes (it maintains at 50 degrees C for 24 hours after magnetizing 100%), and warming -- aging of magnetic field strength was compared about the case where it does not process.

[0053] warming -- the rate of magnetization of the processed permanent magnet -- 99% and warming -- the rate of magnetization of the permanent magnet which is not processed was set up to 100%. And temperature was maintained at the permanent magnet without the opposing magnetic field

by 32 degrees C during the experiment. drawing 6 shows -- as -- warming -- the case where it processes -- warming -- the rate of change of magnetic field strength can be sharply made small from the case where it does not process.

[0054] Below, other examples of an experiment are explained with reference to drawing 7 . here -- as a permanent magnet -- NEOMAX-47 -- using -- a permanent magnet -- 55 degrees C -- warming -- the case where it processes, the case where opposing magnetic field demagnetization processing is carried out, and warming -- change of the magnetic field strength to a temperature rise was compared about the case where neither processing nor opposing magnetic field demagnetization processing is performed.

[0055] "55 degree C -- warming -- after processing" magnetized the permanent magnet 100%, it was maintained at 55 degrees C for 2 hours, and made the rate of magnetization 99.9%. the surface magnetic field strength after "opposing magnetic field demagnetization processing" magnetizes a permanent magnet 100% -- 55 degrees C -- warming -- it demagnetized, raising an opposing magnetic field so that it may become equivalent to the case where it is processing.

[0056] drawing 7 shows -- as -- 55 degrees C -- warming -- when [which was processed] a case and opposing magnetic field demagnetization processing are carried out, the magnetic-field-strength rate of change to a temperature rise becomes small sharply from the case where these processings are not carried out. furthermore, 55 degrees C -- warming -- when it processes, the magnetic-field-strength rate of change to a temperature rise becomes small from the case where opposing magnetic field demagnetization processing is carried out. this -- warming -- although processing acts on homogeneity to the whole permanent magnet, it is because opposing magnetic field demagnetization processing cannot make demagnetization by the opposing magnetic field easily act on homogeneity to a permanent magnet.

[0057] From the result of drawing 6 and drawing 7 , if the permanent magnet which processed [warming-] or processed [opposing-magnetic-field-demagnetization-] is used as the main magnet and/or a magnet for magnetic-leakage-flux prevention, demagnetization by aging or the temperature rise of the main magnet or the magnet for magnetic-leakage-flux prevention can be controlled, and change of the magnetic field strength after assembling a field generator, and the fall of a field uniformity coefficient can be controlled.

[0058] Furthermore, magnetic-flux distribution of a field generator is shown in drawing 8 . Drawing 8 (a) shows magnetic-flux distribution of

the field generator which has a magnet for magnetic-leakage-flux prevention, and drawing 8 (b) shows magnetic-flux distribution of a field generator without the magnet for magnetic-leakage-flux prevention. In addition, 0.262T and the main magnetic field strength in the case of drawing 8 (b) of the main magnetic field strength in the case of drawing 8 (a) were 0.215T.

[0059] While guiding magnetic flux between magnetic pole plates when the magnet for magnetic-leakage-flux prevention is used so that drawing 8 (a) and (b) may be compared and understood, the magnetic flux of the outside of the magnet for magnetic-leakage-flux prevention becomes a non-dense. In other words, it can be said that it is in the condition of repelling mutually the magnet for magnetic-leakage-flux prevention, and a permanent magnet group, there being, and being easy to demagnetize. Therefore, in the field generator using the magnet for magnetic-leakage-flux prevention, when temperature rises, magnetic field strength and its distribution become easier to change. Therefore, if this invention is applied to the field generator using the magnet for magnetic-leakage-flux prevention, degradation of a field uniformity coefficient can be controlled and it is effective.

[0060] Moreover, the R-Fe-B system magnet used for a permanent magnet 18 or 28 can control heat demagnetization by stopping beforehand the rate of magnetization of a R-Fe-B system magnet like an above-mentioned operation gestalt, although it is comparatively easy to generate heat demagnetization at low temperature compared with a ferrite magnet or a Sm-Co magnet.

[0061] When a high residual magnetic flux density is required of a permanent magnet 18, the ternary system R-Fe-B system magnet which does not contain Co substantially as mentioned above is used. In this case, since heat demagnetization becomes large compared with the permanent magnet containing Co, the effectiveness which adopts an above-mentioned operation gestalt is large. Also when using the magnet which furthermore does not contain Dy substantially, the effectiveness which adopts an above-mentioned operation gestalt is large.

[0062] Moreover, since change of magnetic field strength and aggravation of a field uniformity coefficient can be controlled, even if the error of the homogeneity field space F, i.e., magnetic field strength, is the case where less than 100 ppm field space is needed, in an opening, it is easy to suppress the error of magnetic field strength within the limits of above-mentioned. Furthermore, even if it is the case where a field generator is conveyed by the container whose air-conditioning is not enough, for example, change of magnetic field strength and aggravation

of a field uniformity coefficient can be controlled. Moreover, even if it is the case where variation tends to become [the magnetic field strength of the homogeneity field space F] as large as more than 0.25T greatly, change of magnetic field strength can be controlled.

[0063]

[Effect of the Invention] according to this invention, the assembled field generator is with time -- it is -- it is -- demagnetization by environmental factors, such as a temperature rise, can be controlled. Therefore, the fall of the magnetic field strength after transportation of a field generator and aggravation of a field uniformity coefficient can be controlled, and when a field generator reaches an installation, it can maintain a high field uniformity coefficient.

[0064] Moreover, if the whole field generator is warmed after the assembly of a field generator, even if there is change of environmental factors, such as a temperature rise, the field generated with a field generator is stabilized over long duration, and the fall of the magnetic field strength after transportation of a field generator and aggravation of a field uniformity coefficient can be controlled. When warming after assembling a magnetic pole unit, the fall of the magnetic field strength after transportation of a field generator and aggravation of a field uniformity coefficient can be controlled similarly.

[0065] furthermore, the fall of the magnetic field strength after transportation of a field generator similarly after warming in a magnetic phase, when magnetizing and aggravation of a field uniformity coefficient -- it can control -- moreover, warming -- warming small to processing -- equipment can be used. Moreover, since the fall of the magnetic field strength after transportation of a field generator and aggravation of a field uniformity coefficient can be controlled and it can process in the state of a magnet further similarly when demagnetizing, after magnetizing a magnet, working efficiency improves.

[Translation done.]

2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective view showing 1 operation gestalt of this invention.
[Drawing 2] It is the illustration Fig. showing the important section of the operation gestalt of drawing 1 .
[Drawing 3] It is the perspective view showing an example of the permanent magnet group used for this invention.
[Drawing 4] It is the illustration Fig. showing an example of the magnetization equipment used for this invention.
[Drawing 5] warming used for this invention -- it is the illustration Fig. showing an example of equipment.
[Drawing 6] It is the graph which shows aging of the magnetic field strength of a permanent magnet.
[Drawing 7] It is the graph which shows change by the temperature rise of the magnetic field strength of a permanent magnet.
[Drawing 8] Magnetic-flux distribution of the field generator with which (a) has a magnet for magnetic-leakage-flux prevention, and (b) show magnetic-flux distribution of a field generator without the magnet for magnetic-leakage-flux prevention.
[Description of Notations]
10 Field Generator
11a, 11b Magnetic pole unit
12a, 12b Tabular yoke
14a, 14b Permanent magnet group
16a, 16b Magnetic pole plate
18 28 Permanent magnet
24 Annular Projection
40 Support Yoke
50 Magnetization Equipment
60 Warming -- Equipment
F Homogeneity field space

[Translation done.]

* NOTICES *

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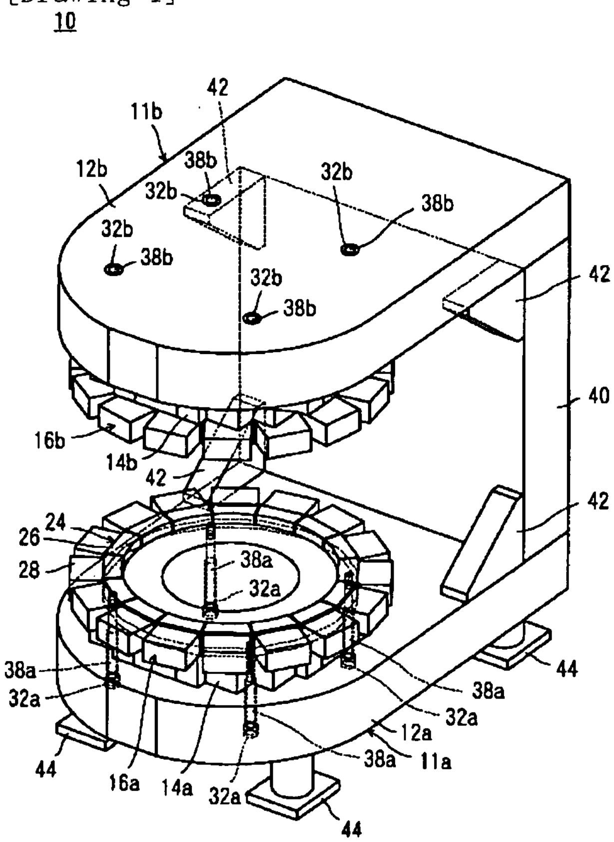
1. This document has been translated by computer. So the translation may not reflect the original precisely.

2. **** shows the word which can not be translated.

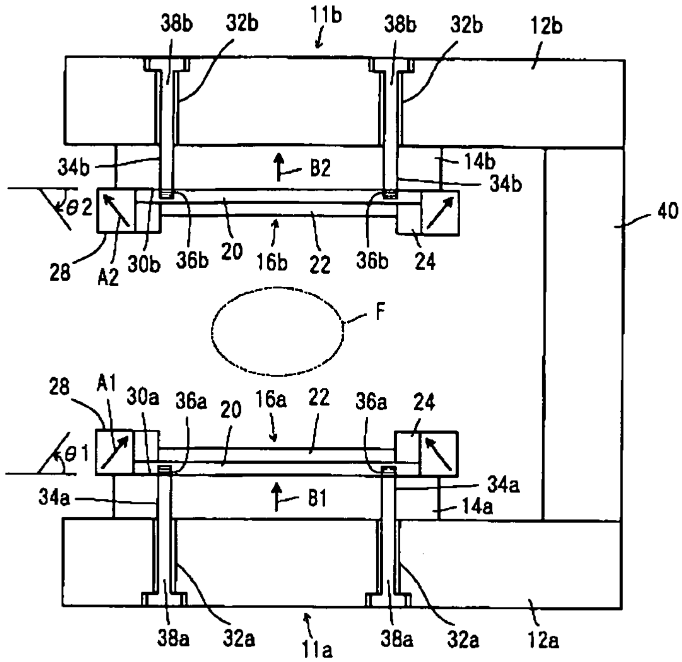
3. In the drawings, any words are not translated.

DRAWINGS

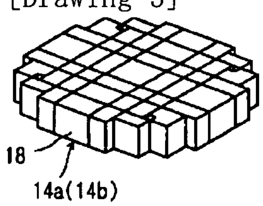
[Drawing 1]



[Drawing 2]



[Drawing 3]



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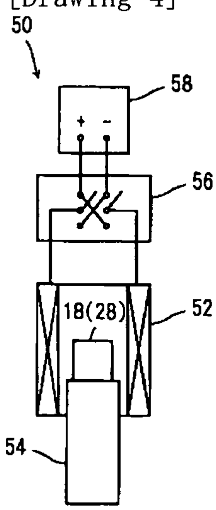

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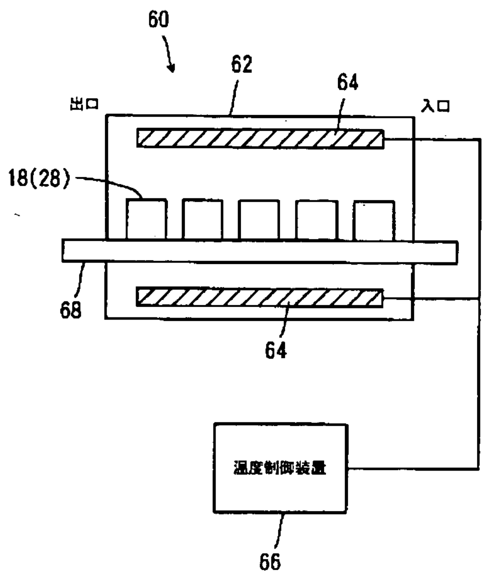
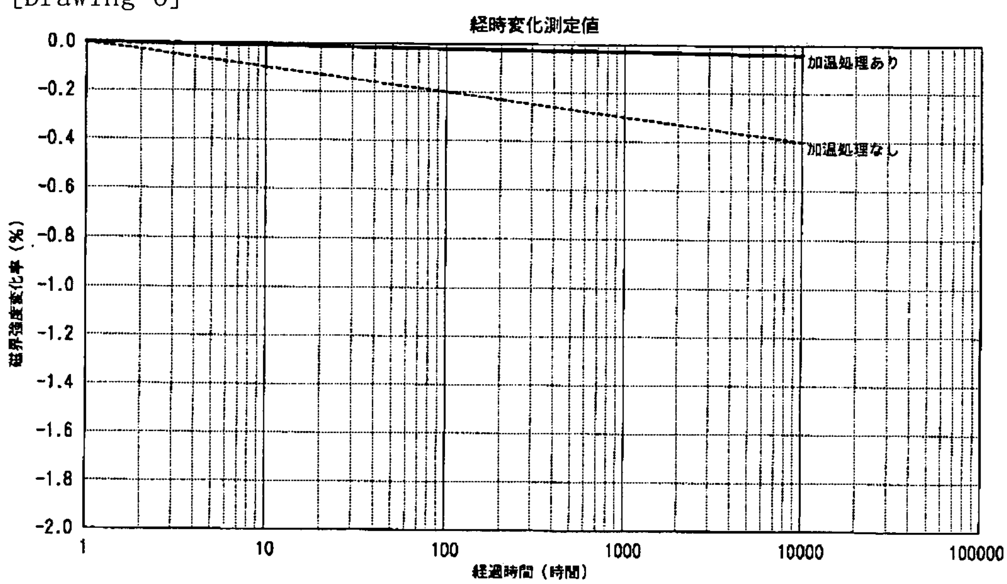
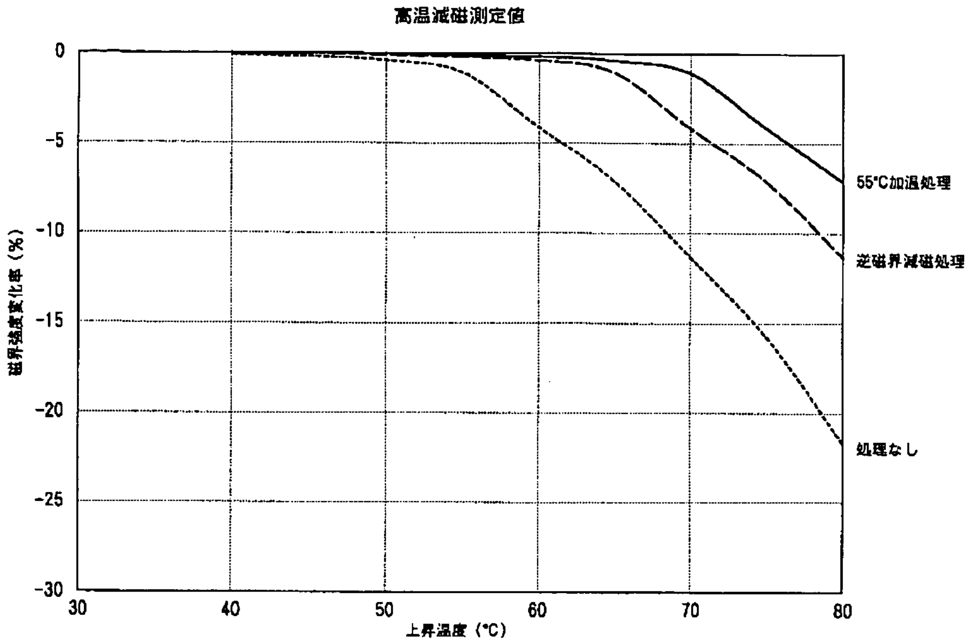


[Drawing 6]

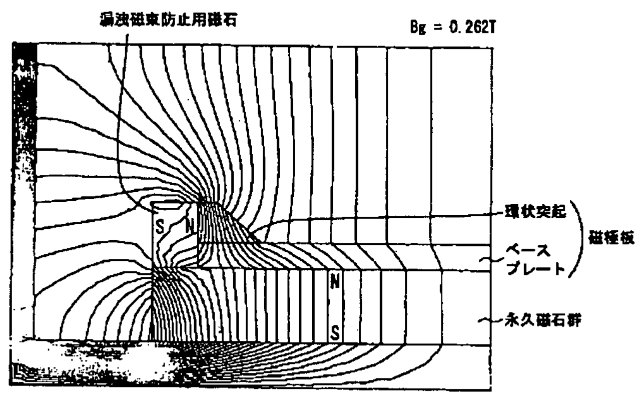


[Drawing 7]


高温減磁測定値
0
-5
-10
-15
-20
-25
-30
30
40
50
60
70
80
磁界強度変化率（%）
上昇温度（°C）
55°C加温処理
逆磁界減磁処理
処理なし

[Drawing 8]

(a)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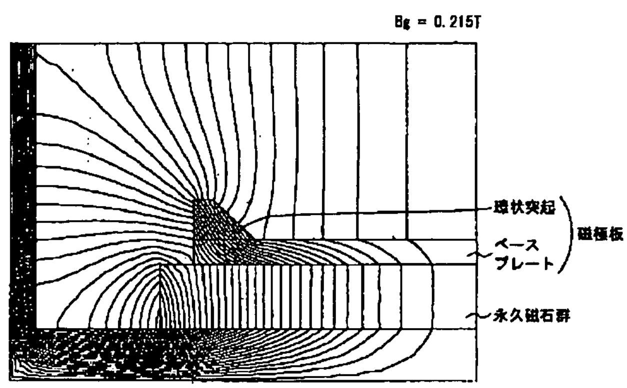
S
N
N
S
環状突起
磁極板
ベース
プレート
永久磁石群

(b)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磁極板
ベース
プレート
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[Translation done.]